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WATERWAY TRAFFIC ON THE GREAT LAKES

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WATERWAYS DIVISION

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PAPERS

WATERWAY TRAFFIC ON THE GREAT LAKES

BY JOHN R. HARDIN,[1] M. ASCE

SYNOPSIS

Since the earliest times in United States history, the Great Lakes have been a vital artery of commerce, serving an area rich in natural resources and industrial facilities. From meagre beginnings as storm havens for sailing vessels, great harbors have been developed and are maintained by the Great Lakes Division of the Corps of Engineers, United States Army.

The work of this division in improving harbor and navigational facilities is recounted. Statistics are cited to show the magnitude of commerce carried by the Lakes and the dependence of this shipping on constant maintenance of channels and harbors.

The increase of Great Lakes trade to world-wide scope would be made possible by construction of the St. Lawrence River Seaway facility, and the cost and significance of this project is discussed.

INTRODUCTION

Early History.—During the advance and retreat of the glacial ice sheet many centuries ago, the ancestors of our present Great Lakes were born. From a geographic, historic, and economic standpoint, the Great Lakes with their connecting channels constitute the most important body of fresh water in the world. This paper is intended to treat in general terms the development and characteristics of navigation on the Great Lakes.

For sheer size, the Lakes are tremendously impressive. With their connecting channels they form a natural transportation highway having a water area of more than 95,000 sq miles and a shore line of more than 8,300 miles. From Montreal, Que., Canada, at the head of deep draft ocean navigation on the St. Lawrence River, the sailing distance to the westerly end of Lake Superior is about 1,340 miles and to the south end of Lake Michigan about 1,250 miles.

NOTE.—Written comments are invited for publication; the last discussion should be submitted by **February 1, 1952.**

[1] Military Constr. Div. of the Office, Chf. of Engrs., Washington, D. C.

Surrounding the Lakes is a region rich in many natural resources. At one time the shores were covered with virgin timber. Iron ore, limestone, and coal, also, have been found in abundance in the area. Some of the most productive of our agricultural lands lie close to the Lake shores. With all these blessings from nature, the Great Lakes area was destined from its very discovery to become an important center of industrial and commercial development. Because of the ease of transportation on the Lakes, for example, the French had established outposts as far west as the Saskatchewan Valley, while in the same period the Dutch and English were penetrating only a few miles inland from the Atlantic seacoast. The French, of course, followed the Indians who had settlements along the shores of the various Lakes and had worked the copper deposits found in rocky outcroppings. Frail birch bark canoes were the first type of transportation on the Lakes used by the Indians, French explorers, and missionaries. The hardy fur trappers, however, built bigger canoes, some holding as many as 9 persons and as much as 8 tons of furs.

Not satisfied with the Great Lakes waterway system as nature left it, these dynamic fur traders made the first improvements to Lake navigation facilities. They built a canal and lock to eliminate the portage around St. Marys Falls between Lake Superior and Lake Huron. This canal and lock was built by the Northwest Fur Company in 1797 on the Canadian side of St. Marys River. The lock was 38 ft long, 8 ft, 9 in. wide and had a lift of 9 ft. A towpath along the shore permitted oxen to pull the canoes and bateaux through the entrance channels and lock. The remains of this old lock may still be seen at Sault Ste. Marie, Ont., Canada.

In those early days when fur and trade goods were the principal cargoes, oversize canoes and flat bottom bateaux were adequate for the economic needs, and the natural navigation conditions of the Lakes required little improvement. The restless march of progress was underway, however, and in 1797 pioneers at Erie, Pa., built the first sailing vessel on the Lakes. About 20 years later, the first steam-powered vessel for Great Lakes use was built at Oswego, N.Y. An interesting account of navigational activities during the early days has appeared previously.[2]

Federal Activities

As the nation's commercial and industrial tempo quickened and more ships were built, both shippers and the general public demanded better harbor facilities. In consequence, the United States Federal Government authorized its first river and harbor program in 1824. Federal harbor improvements were authorized on the Great Lakes at Erie, in 1824; at Cleveland, Ohio, and Fairport, Ohio, in 1825; at Buffalo, N.Y., and Ashtabula, Ohio, in 1826; and at Chicago, Ill., in 1833. A few years later, in 1841, Congress authorized a $15,000 appropriation for the charting of 9,500 sq miles of the Great Lakes system. The survey was for the purpose of furnishing charts to Lake navigators and determining further improvements necessary to maintain the prosperity of the rapidly growing Lake commerce. Under the direction of the Corps of

[2] "Great Lakes Transportation," by M. C. Tyler, *Transactions*, ASCE, Vol. 105, 1940, p. 167.

Engineers, the Lake Survey has been a continuing work and has to its credit numerous contributions to the science of hydrographic surveying. Among other things, the Lake Survey devised and perfected the "wire sweep" which today is the accepted method of locating underwater obstructions. The Survey designed and built the first metal tower for use in triangulation survey work, the first electric recording current-meter, and it was the first United States governmental agency to print navigational charts in color. Since its inception, the Lake Survey unit of the Corps of Engineers has been the recognized leader in the American effort to facilitate navigation on the Great Lakes.

In the early days, when the federal government first became concerned with improving inland harbors, inter-lake traffic was restricted by physical obstacles between Lakes Erie, Huron, and Michigan. Navigation between Lake Erie and Lake Ontario was blocked by the falls of the Niagara River, and communication with Lake Superior was impracticable because of the falls of St. Marys River. The original Northwest Fur Company lock had been destroyed in 1814. Until 1855, the movement of freight to and from Lake Superior was by boat to Sault Ste. Marie, at which point cargoes were unloaded, portaged across a mile-long tramway, and reloaded on boats. When the State of Michigan completed a 10-ft draft canal around the rapids in 1855, Lake Superior was again opened to the small boats then in use. A few years earlier, traffic had been opened between Lake Erie and Lake Ontario when Canadian private interests built a small canal in the general vicinity of the present Welland Canal.

Vessels Used in Great Lakes Traffic.—As the Great Lakes region developed agriculturally and industrially, Lake traffic increased steadily, with a corresponding increase in the number and size of vessels. Generally speaking, the federal government in the ensuing years developed harbors and connecting channels to keep pace with prevalent Lake transportation needs. Until 1883, there were more sailing ships than steamers on the Lakes. Obviously, the harbors and connecting channels required by light-draft sailing vessels and small side-wheel steamers were quite different from those required for larger vessels. For example, in the days when three-masted schooners plied the Lakes, carrying manufactured and package freight to the outposts of the Lake region and returning with cargoes of lumber and grain, there was a vital need for many harbors of refuge, to which the light-draft vessels could run for protection when severe storms and squalls made the Lakes hazardous. By 1900, the vast majority of the lake schooners had disappeared. If technological progress had not already doomed the colorful sailing ships, their ultimate fate was sealed in 1892 when iron ore from the Mesabi Range was first shipped to lower lake ports. To handle this heavy bulk cargo economically, larger ships with deeper drafts were a necessity. Bigger ships, of course, required deeper channels and better harbors. The demand for these improvements generally followed the flow of commerce on the lakes.

When the ore trade started on the Lakes, steamers as well as sailing ships were poorly adapted for ore carrying. They had small capacity and were difficult to load and unload. To Captain Alexander McDougall goes the credit of designing the highly specialized ship commonly known as the bulk

freighter. These ships have the pilot house moved forward and the engines aft, leaving nothing amidships to interfere with the main cargo space. Both the ships and the shore installations for loading and unloading are fully coordinated, each having been designed to fit the other. Hatch openings on most ships have the same spacing as the loading chutes on the ore wharves so as to facilitate loading without moving the ship. Unloading equipment has been designed so that as little time as possible need be spent in port.

More than $\frac{2}{3}$ of the ships on the Lakes are over 450 ft long, and some are about 600 ft long, with a beam of 60 ft and a draft of 32 ft. The larger boats carry about 17,000 tons of iron ore at maximum draft. A trend toward even larger boats for the ore trade may be seen in the launching of the S. S. Wilfred Sykes, which is 678 ft long, 70 ft wide, and can carry 20,000 tons of ore at 24-ft, 6-in. draft. With a loaded speed of 16.5 miles per hr, the Sykes will be able to make 44 round trips during the navigation season, as compared with 34 round trips for the average ship in the ore fleet.

Commerce on the Lakes

Discounting the lumber trade that went into a decline about 1910, since the turn of the 20th century at least 80% of the commerce on the Great Lakes has been in four commodities—grain, iron ore, limestone, and coal. Therefore, development of navigation facilities has been influenced to an appreciable extent by the requirements of vessels hauling these cargoes.

In 1948, when lake traffic was the heaviest on record up to that time, iron ore, coal, limestone, and grain composed 86% of the commerce on the Great Lakes. Of a total of 217,548,101 net tons of traffic, iron ore alone constituted 91,791,144 net tons. Most of this ore was mined in the Lake Superior regions, and moved through the Soo Canal Locks to destinations on the southern end of Lake Michigan and to ports on Lake Erie.

Coal accounted for 66,924,551 tons of the Lakes' traffic in 1948 and to a large extent reversed the flow taken by iron ore. Most of the coal was shipped from Lake Erie ports, with Lake Superior and Lake Michigan ports as its destination.

Stone, which constituted the third largest tonnage at 22,349,287 net tons, was shipped principally from Lake Huron and upper Lake Michigan ports. While most of the stone shipments were generally southbound to lower Lake Michigan and Lake Erie destinations, a substantial amount of stone also was shipped into Lake Superior.

Grain comprised 6,496,769 tons of Lake commerce in 1948. The major portion of this tonnage was shipped from Lake Superior ports, although sizable shipments of corn were made from Chicago and Milwaukee, Wis., on Lake Michigan. More then half the grain carried on the Lakes in 1948 was destined for shipment to Boston, Mass.

Of course, in addition to these four major items there are many commodities carried on the Lakes. It may be interesting to note that cargoes of timber and pulpwood at one time formed the original bulk freight traffic on the Lakes and then practically disappeared, but these shipments are returning. However, the forestry products now are imported mainly from Canada and Scandinavian

countries. Package freight, once a thriving form of traffic, appears to be reviving to some extent. All of these changes have been reflected in the growth, and sometimes the decline, of harbors on the Lakes. To meet the needs of one period in history ports have sprung up, some have changed radically, and others have dropped into obscurity. Two good examples of how harbor growth is affected by changes in commerce are the cases of Grand Marais and Holland, Mich.

In the late 1890's Grand Marais was a bustling, prosperous lumber shipping port. In one year the harbor handled 160,000 tons of cargo, mainly forest products. When the virgin forests were stripped, however, the town went into a decline, and in 1947, the only shipments at the harbor were 222 tons of a local catch of fresh fish. Holland, Mich., also got its start back in the heyday of the lumber trade. In the 1890's Holland harbor in one year handled 307,000 tons of cargo, of which 104,000 tons was lumber. When the lumber trade fell off, Holland harbor had a few bad years but soon kept moderately busy with package freight business, despite competition of rail and highway transportation. The harbor has again been teeming with activity in coal, gasoline, cement, and stone shipments, and in 1947 Holland harbor handled more than 240,000 tons of commercial traffic. Grand Marais still serves a useful purpose as a base for Lake Superior fishermen and as a harbor of refuge for recreational craft and other lake vessels. Therefore, it is desirable that the federal government continue to maintain it for use. Holland harbor, of course, has justified its continued existence as a commercial harbor, eligible for federal maintenance.

Navigational Works

Federal navigation works on the Great Lakes, as far as the Corps of Engineers is concerned, have been primarily of two categories—development of harbors and improvement of connecting channels between the Lakes. The question of why the federal government assumed the responsibility for river and harbor work is sometimes asked. The answer is quite simple, in that such improvements are costly and the cost usually far exceeds the benefits ordinarily derived by any local community in which a harbor may be located. Take, for example, the harbor at Ashtabula, Ohio. At that port, millions of tons of coal are shipped and iron ore received but none or very little of it is used locally, most of it being shipped to and from the Ohio-Pittsburgh (Pa.) area. The benefits derived from harbors are national in scope, and Congress decided at a very early date that the national government is responsible for making improvements to harbors and connecting channels. The Corps of Engineers, under authority from Congress, provides and maintains entrance channels, main harbor channels, harbor areas, anchorage areas, and protective breakwaters and jetties required for the needs of general commerce and navigation.

Development of Harbors.—The first improvements undertaken by the United States Government on the Great Lakes were mainly the construction of channel entrance works. Because the Great Lakes have few natural harbors, the mouths of the larger rivers entering the Lakes and, to a lesser extent, the lee sides of islands and points of land afforded protection and anchorages

for the first commercial vessels to ply these waters. The early settlements usually were made at or near these important river mouths on natural lines of communication with the hinterland. Therefore, early harbor improvements consisted largely of building jetties to improve navigation over the bars which normally form at the mouths of streams that enter currentless bodies of water. These works were first built by local governmental agencies, or in some cases by private interests, but since 1825 the major commercial harbors have been improved by the federal government. About 80 active commercial lake harbors, representing an aggregate expenditure for construction and maintenance of about $350,000,000 over a period of about 125 years, have been constructed or improved and are being maintained by the federal government.

Harbor works on the Great Lakes are generally similar in character to those of artificial or partly artificial harbors on seacoasts. They are, however, in some cases lighter in section since they are subject to less severe wave attack. Furthermore, the absence of the marine borer, known as the teredo, and a former abundance of timber along Great Lakes shores has led to a much wider use of timber crib and timber pile construction than is usual in salt water. The fact that the Great Lakes are, to all intents and purposes, tideless bodies of water has also simplified harbor design and construction. Federal works at the harbors usually consist of construction and maintenance of breakwaters and protective piers, and the dredging and maintenance of main navigation channels. While a generalization about harbors on the Great Lakes is difficult because of widely different conditions encountered, it is safe to say that harbor entrances usually are built 500 to 700 ft wide. As a general rule of thumb, it also may be said that the minimum distance from the entrance gap to the nearest dock line is at least 3 to 3.5 boat lengths.

Depths of harbors vary within wide limits, depending on the primary purpose for which they were constructed and their present importance. Harbors in which large ore docks are located, for example, are at least 26 ft deep. In the Chicago area there are five harbors, and each of them is of a different depth, ranging from 18 ft to 28 ft draft. All harbors are slightly deeper at the entrance to allow for pitch of the ship in open water as it enters the protected area. In developing channels within harbor areas, the Corps of Engineers is guided by the criteria that such channels must be in use by general navigation. In other words, the Corps of Engineers is not authorized to develop private wharves or slips. Before recommending any navigation improvement, the Corps of Engineers, acting only upon directives of the Congress, makes a thorough study of the proposal, including the anticipated annual cost of the improvement as compared with anticipated annual benefits. As a general rule, only those improvements in which the benefits may be expected to equal or exceed the charges and in which the benefits tend to accrue to the public at large are recommended for favorable action.

Among the largest of the major improvement projects currently in progress (1951) in the Great Lakes Division of the Corps of Engineers are the harbors at Cleveland, Ohio, and Buffalo, N. Y. The work at Cleveland consists of improvement of the Cuyahoga and Old Rivers by dredging to a depth of 23 ft and the replacement or reconstruction of 7 railroad bridges. The estimated

cost of this work is about $19,000,000. At Buffalo the project consists of deepening the north entrance of the harbor to 25 and 26 ft and deepening the Buffalo River and Ship Canal to 22 and 23 ft. This project is estimated to cost approximately $12,000,000.

In these and other harbor projects, local interests are cooperating in making the improvement possible. The amount of local cooperation required varies widely, but the element of local cooperation must always be present. Local interests participate in port development by contributing funds when warranted, furnishing necessary lands, easements, and rights-of-way, providing adequate terminal facilties, and maintaining berthing areas and approaches to docks. On the other hand such "local cooperation" is not required in the improvement of channels outside of harbor areas. It would clearly be unfair to ask the city of Sault Ste. Marie, for example, to pay part of the costs of the locks at St. Marys Falls, or to ask the little town of Marine City, Mich., to pay for channel dredging in the St. Clair River.

Maintenance of Navigation Channels.—Improvement of navigation channels, particularly those connecting the various lakes, has been a vast undertaking that was started around 1850 and is still continuing. Of special interest from an engineering point of view has been the construction of the Soo Canal Locks and rock excavation and general dredging in the St. Marys and Detroit Rivers. The execution of the work in such a manner as not to disturb the water levels in Lake Superior, Lake Huron, and Lake St. Clair has been a delicate and very interesting problem.

Lakes Superior and Huron are connected by the improved St. Marys River, 63 miles long. Because Lake Superior is 22 ft higher than Lake Huron, the Soo Locks and compensation works are necessary. Connection between Lakes Michigan and Huron is by way of the Straits of Mackinac, which have required little improvement to provide suitable depths for navigation. From the lower end of Lake Huron the improved connection with Lake Erie, about 80 miles long with a drop of 8 ft, consists of the St. Clair River, Lake St. Clair, and the Detroit River. In dredging and maintaining these navigation channels, it is common to make channels for loaded ships a minimum of 25 ft deep and channels for empty vessels at least 21 ft deep. At average lake levels, these depths provide for 23-ft draft for loaded oreboats sailing from Lake Superior to Lake Erie, Lake Huron, and Lake Michigan ports, and a somewhat shallower draft for the same boats returning loaded with coal and other products that do not weigh as much per cubic foot as iron ore.

Maintaining these channels to authorized depths is a very exacting and serious matter and a continuous activity of the Corps of Engineers. Because the navigation season on the upper Lakes is only about 8 months per year, shippers load their vessels as heavily as possible, consistent with safety and marine regulations. Therefore, a 1-ft or even a 6-in. difference in channel depths is a matter of grave concern from the standpoint of safety as well as of economics. Complicating the problem is the fact that mean annual lake levels fluctuate from year to year—sometimes as much as several feet. The importance of these interconnecting channels to the economic well-being of North America may be judged from the fact that more tonnage passes through

the St. Marys Falls Canal locks than through any other canal in the world—and the further fact that the Port of Duluth-Superior handles a greater tonnage than any other port in North America, excepting the Port of New York.

The greatest amount of annual traffic on the Great Lakes during the period from 1935 to 1950 was 217,548,101 tons in 1948. The total cost of maintenance and operation of navigation channels and structures for the same year was $5,584,906 or about 2.5 cents per ton of commerce. As previously mentioned, the total federal expenditures to date (1950) for navigation works, including operation and maintenance of both harbors and channels, but excluding expenditures for lighthouses, channel markers, and similar aids to navigation, is about $350,000,000. If this entire expense were to be accounted for in one year, it would amount to only $1.60 per ton of freight carried in 1948. The total cost related to the total commerce carried on the lakes since 1825 amounts to only a few cents per ton.

Throughout the years, the savings in freight costs made possible by the water route of the Great Lakes have been many times more than the federal expenditure for improvements and maintenance. Because these benefits have extended to the entire nation and ultimately have resulted in lower prices to the American consumer, no toll or fee has ever been charged for the use of the federally improved navigation facilities which are wholly within the United States. This policy of toll-free waterways is in keeping with our earliest national declaration of policy concerning the use of the Lakes and other inland water courses.[3]

> "The navigable waters leading into the Mississippi and St. Lawrence, and the carrying places between the same, shall be common highways, and forever free as well to the inhabitants of the said territory as to the citizens of the United States and those of any other state that may be admitted into the confederacy without any tax, impost, or duty thereon."

Congress also has repeatedly stated that its policy is to maintain the inland waterways as toll-free highways for commerce. This toll-free policy has contributed materially to the industrial development of the Great Lakes area and to the prosperity of the peoples of the United States and Canada.

The Continuing Need for Lake Commerce

While the facts speak for themselves concerning the value of Great Lakes navigation, questions sometimes arise concerning the long-range aspect. Actually, it is unthinkable that the United States Government would fail to provide adequate transportation facilities for the iron and steel industry in the Lakes region. Too much of our economic life blood is tied up with the production of iron and steel at competitive prices to permit the collapse of Lake navigation for want of adequate facilities. Much is said and written about the future of iron ore sources for this industry. Most authorities say available sources of high-grade ore in the Lakes region are limited; others deny it, claiming that it is only required to explore and develop additional deposits in the Mesabi Range or develop methods of using different types of

[3] "The Ordinance of 1787," The Northwest Territorial Government, The Confederate Congress, July 13, 1787, Article IV.

ores. However, the long-term view would indicate that when the time comes, suitable channels for that traffic should be ready, if existing mills in the Great Lakes area are to continue to function.

The St. Lawrence Seaway Project.—Therefore, the key to the long-term future of the Great Lakes commerce is the St. Lawrence River Project. The St. Lawrence Seaway would provide a direct gateway for vessels between the Great Lakes and the sea. Engineering studies including the extensive planning for the St. Lawrence River portion indicate that the problem of providing channels and locks is of considerable magnitude, but traffic estimates made by the United States Commerce Department show that the proposed expenditures for the navigation phases of the St. Lawrence Seaway are economically sound.

From the head of the Great Lakes at Duluth to Montreal, the Great Lakes-St. Lawrence Seaway Project proposes a controlling channel depth of 27 ft with a depth of 30 ft over lock sills. Canadian engineers have exercised great foresightedness in building the Welland Canal with locks of 30-ft depth over the sills, and with 25-ft depths in the Canal. These depths in the Canal can be increased, as required by future traffic, to provide a 30 ft depth between Lakes Erie and Ontario. Such foresight greatly simplifies the problem of building the seaway. The cost of completing a 27-ft channel project for the St. Lawrence River is estimated at $818,063,000, based on December, 1950 price levels. A seaway with a 27-ft channel can carry a great amount of traffic, as witnessed by activities on the Great Lakes where such depths are in use. The trend in American shipping, however, is to deeper and faster ships for reasons of economy; so studies have been made also of the possibility of constructing the St. Lawrence Seaway with 30- and 35-ft channels. The maritime commission estimates that a 30-ft channel could readily accommodate 80 to 85% of the present United States ocean-going merchant fleet with little or no restriction. The cost of completing a 30-ft channel, based on December, 1950 price levels, is estimated at $1,078,815,000, and the cost of a 35-ft project is estimated at $1,840,889,000.

Had the St. Lawrence Seaway been constructed prior to World War II, there is little doubt that combat ships, up to and including the destroyer and cruiser classes, and merchant ships of the Liberty type could have been constructed in the relative security of the Great Lakes area. At Great Lakes ports ships could have been loaded with supplies, munitions, and war armament produced in factories in the Lake region, and they could have then proceeded in convoy through the St. Lawrence River and by the Great Circle route to Europe, greatly reducing the submarine hazard.

There can be no question concerning the long-range value of the St. Lawrence project. Some shippers on the Great Lakes, however, have raised the question as to whether opening of the seaway would make present navigation facilities obsolete. Of course, some channels, harbors, wharves, and slips would have to be enlarged to accommodate larger vessels when such are built and enter the Great Lakes from the ocean. This can be accomplished gradually, for it will require several years to complete the seaway after the project is approved and funds are made available. The question of the practicability of using

present Lake vessels for Labrador ore transportation also has been raised, and has been given careful consideration by the Lake Carriers Association. It is their conclusion that, with some minor changes, the larger ships now in use on the Lakes for ore transportation are well adapted for the Labrador run.

Conclusion

As near as can be determined from traffic statics, commerce on the Great Lakes has a bright future. The guiding policy will continue to advocate a step-by-step development of federal navigation facilities in keeping with shipping needs as evidenced. In all cases, benefits will have to be definitely demonstrated on favorable economic ratios; in this way unwise expansion can be avoided and expenditures reduced to annual amounts within a reasonable budget and in keeping with the other financial burdens on our country.

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